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The Effect of Intellectual Property Protection on Economic Growth

Andrew Jonathan Mahurin
Wright State University - Main Campus

The Effect of Intellectual Property Protection on Economic Growth

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By ANDREW JONATHAN MAHURIN
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I HEREBY RECOMMEND THAT THE CAPSTONE PROJECT PREPARED UNDER MY SUPERVISION BY Andrew Jonathan Mahurin ENTITLED The Effect of Intellectual Pproperty Pprotection on Economic Growth BE ACCCEPTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE

Evan Osborne, Ph. D.
Project Supervisor

Robert Premus, Ph. D.
Project Reader

Leonard Kloft, Ph. D.
Program Director

Abstract

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This paper tests whether stronger intellectual property protection is good for a country. It focuses on the overall effect of intellectual property protection on per capita economic growth. To measure the strength of intellectual property protection, I use the Ginarte-Park index. An education and an investment variable are also included in the models.

The models are based on simple linear regressions involving a cross-section of countries. The models consistently showed a negative correlation between intellectual property protection and per capita economic growth. Moreover, I tested to see if the effect is different in some countries than in others, based on an interaction with either education or investment levels. No conclusive interaction was found. Finally, I divided the sample into two sections, based on whether each country had a high or low level of intellectual property protection. The negative correlation between intellectual property protection and economic growth was weaker statistically for the group of countries with high intellectual-property protection levels.

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Preface

It is good to know about the biases, background, and experiences of a researcher. It is also good to know about a researcher's goals and expectations for doing a certain type of research. All of these can affect the way research is conducted, the way theories are built, and the way data is interpreted.

In regards to the possibility of bias, I am a fan of open-source software products such as Linux. The whole idea of open-source software has made me question whether copyright law should be structured the way it is, or whether there is a better system. My perspective is also influenced by my educational background. During my undergraduate studies, I studied music composition. The music that I wrote is protected by copyright law, and I always put a copyright notice on the bottom of every new composition. So, balancing these two influences, I think my bias was neutral overall.

I spent 2006 in China, and some of the observations I made affected the development of my theory section. To me, China is a good example of a developing country, and the United States is a good example of a developed country.

There are several areas that can be researched as a follow up to this paper. First, it would be good to know more about the motivations that cause an individual country to increase its intellectual property protection. Such a study would branch off into political science, sociology, or psychology, depending on whether decisions are being traced to a political process, a social phenomenon, or individual decision makers. It would be good to know how an individual country was expecting to benefit from such a change. This paper is written from the assumption that many countries institute intellectual-property protection systems as part of their economic growth strategies.

A second area of possible research is related to the first. If countries typically manage their intellectual property protection systems based on an economic growth strategy, how does the intellectual property system fit into their overall strategy? Individual countries could be analyzed this way, taking into account the individual country's entire growth strategy. Since similar countries often pursue similar growth strategies, groups of similar countries could be also analyzed in this way.

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Introduction

Economic growth is one of the most fundamental issues of economics. Adam Smith was interested in this subject when he wrote his famous book in 1776, The Wealth of Nations. We are still interested in this subject today. How does a nation increase its wealth? This is the key question of so many economic papers. This paper will study the impact of intellectual-property protection.

Intellectual-property protection affects society in so many ways. Scientists, engineers, artists, writers, and many others are all creators of intellectual property. Much of what we buy contains some sort of copyright, patent, trademark, or other form of intellectual property protection. This is seen as necessary because we are in an age of mass production.

Mass production allows a small idea to benefit everyone, if it is made public. In our society, many creators of ideas expect to be rewarded monetarily, or they will not share their ideas. Intellectual property systems exist to help the creators of ideas sell their ideas. As more ideas are shared in the marketplace, society more easily can create value from its limited physical resources. This contributes to economic growth.

This paper analyzes the relationship between the strength of intellectual property protection and the rate of economic growth. To make this analysis, a sound understanding of economic growth is necessary.

Literature Review

There is significant literature on growth theory in general, on intellectual property, and on the interaction between intellectual property and economic growth. Papers on economic growth provide a framework for building a good economic growth model (Paul Romer 1986; Romer 1990; Robert Lucas 1988). Papers on intellectual property rights (Stanley M. Besen and Leo J. Raskind 1991) give an overview of the current laws and how economists usually look at them. Finally, papers on the interaction between intellectual property and various aspects of economic growth (Zvi Griliches 1990; Juan C. Ginarte and Walter G. Park 1997) provide a basis of comparison for my own work.

1. *Literature on Economic Growth*

Manuel S. Santos (2002) says that "there is no model to account for a minimal set of basic facts or empirical regularities in the area of growth and development" (p. 1). In other words, no mathematical model has been completely satisfactory in explaining economic growth, however, certain growth theories have become recognized over the years as being important.

The most dominant economic growth theory was developed by Paul Romer (Romer 1986; Romer 1990; Ronald Bailey 2001; Romer forthcoming 2007). Romer emphasizes the role of human capital (especially education), physical capital (investment), and the amount of existing ideas and designs (patents). These three lead to the development of new useful chemicals, new machines, and more manufactured products for consumption. Whatever wealth is not consumed is reinvested to become physical capital for future growth.

Paul Romer (1986) modified the views of earlier authors by saying that without technological growth, an economy would eventually reach a steady state, a point at which further increases of income per capita would be impossible. When technological growth is added to the model, continuous growth is possible.

Paul Romer's model often is referred to as the New Growth Theory (Olivier Blanchard 2003). Previous theories had focused on savings, investments, and capital accumulation. New growth theory adds the role of technological change, and tries to investigate its causes (Blanchard 2003 pp. 243-266, and pp. 572-581).

One of Santos' (2002) objections to current models is that they cannot completely explain why some countries become relatively rich, while others stay relatively poor. The idea of convergence says that poor countries eventually should catch the rich countries, closing the gap between rich and poor. Santos criticized the idea of convergence, because in his opinion it did not match the data.

Romer (1990) and Robert Lucas (1988) both give discussions that explain why some countries grow faster than others. According to Romer (1990), for every level of knowledge, there is an optimal level of production and research. Production faces increasing returns to scale, while research faces diminishing returns to scale. Research produces knowledge, and investments in research are more profitable as the level of knowledge increases. This will cause more advanced economies to grow at a more rapid rate than poor countries with little technology. This effect will be limited by technology spillovers between countries.

According to Lucas (1988), countries specialize in a good according to comparative advantage. Learning by doing causes the comparative advantage to increase. If two goods are substitutes, the country that specializes in the more learning-intensive good should experience higher growth rates. In the same article, he wrote that learning by doing and formal schooling both create positive externalities.

Within this new area of research, the most important variable seems to be education (Alan B. Krueger and Mikael Lindahl 2001; Santos 2002; Romer 1986). Investment is also an important variable to include, and also is included by Santos (2002) in his model.

Education is important in this literature in several ways. It relates to Romer's (1990) idea of human capital, which is required to push the level of technology forward. It relates to Romer's (1990) discussion on the optimal level of investment in research, because this is based on the level of knowledge, and education plays a role in a society's level of knowledge. Finally, it plays a role in Lucas' (1988) discussion of comparative advantage, because a society that is more educated should have more comparative advantage in learning-intensive industries.

In addition, Jennifer Cheeseman Day and Eric C. Newburger (2002) and the United States Census Bureau (2005) show how education increases the average income of those who pursue it. If income is representative of productivity, then this is evidence that education tends to improve productivity.

Santos (2002) cites gradual productivity improvement as one of two ways that economists usually have explained economic growth. The other type of explanation is a capital-accumulation model. Education also can fit into a capital-accumulation model, because it can be accumulated by gradually investing resources into it. Once acquired, it has a productive value, and can be used to further expand production.

2. *Economic Theory and Intellectual Property Protection*

Stanley M. Besen and Leo J. Raskind (1991) provide the best introduction to a study of intellectual property law. Besen and Raskind (1991) discuss the main categories of intellectual property law, including copyrights, patents, trade secrets, and a special law for computer chip manufacturing. They trace the history of patents to the Constitution, and give the basic reasoning behind the patent system.

The primary goal of an intellectual property system is to promote innovation, by giving monopoly rights to innovators (United States Patent and Trademark Office 2005; Besin and Raskind 1991; Perelman 2003). Monopoly rights give high profits to those who own them, but cause a deadweight loss to society by decreasing the output and reducing the availability of products that have been patented (Paul H. Jensen and Elizabeth Webster 2004; Besen and Raskind 1991). These monopoly rights are seen as necessary because "private producers have an incentive to invest in innovation only if they receive an appropriate return" (Besen and Raskind 1991, p. 5).

Besen and Raskind (1991) do not define "appropriate return." This can be a source of contention, because often neither society nor the inventor can know the importance of an innovation until after it is created, marketed, and put in use. Different types of innovations require different processes in order to be developed.

Nancy T. Gallini (2002) gives another introductory paper, focusing on recent changes in patent law. She lists the changes as broadening the scope of the patent law to cover new areas (such as biotechnology), increasing the ability of patent holders to enforce their claims in court (citing a court decision), and lengthening the term of patents. Gallini discusses whether these changes encourage more innovation, more disclosure, and /or more technology transfer. Gallini also discusses certain side-effects and costs of the recent changes.

Gallini (2002) concludes that the economic impact should be hard to measure at this point, because not enough time has passed since the recent changes. The impact of stronger patents (patents that are easier to enforce in court, and have longer terms) may be mixed.

The Semiconductor Chip Protection Act of 1984 protects the design of a computer chip from being copied or reverse engineered by a competing manufacturer, for ten years (Besen and Raskind 2000). This is a recent development. It illustrates how the law has reacted to the development of the computer chip industry.

As technology progresses forward, other categories may come into existence, for example, computers. We need to evaluate our intellectual property laws periodically to find how they can be optimized for the modern economy.

A few authors have advocated specific changes to our intellectual property laws and customs. Mikko Mustonen (2005) and Nicholas Petreley (2001) advocate open source software. Danny Quah (2002) advocates the free usage, copying, modification, and reselling of all innovations. Quah's argument is that the cost of a copied innovation, like a copy of computer software, is basically costless.

The term open-source was invented by Eric Raymond (2000), and refers to software which has its source code open to the public. Eric Raymond believed that he could write software more efficiently if he posted the source code of his partially complete program on the Internet. He received feedback from other computer enthusiasts who were interested in his program, and he completed his program easily. The open-source movement has been gaining in popularity in recent years, however, this way of thinking has not been advocated by many mainstream economists.

Many papers have been written which advocate weaker intellectual property protection. Those who favor less intellectual property protection say that developing countries often cannot afford to license technology developed abroad. Graham Dutfield (2005) focuses on the specifics of AIDS drugs, complaining that patent laws can restrict the amount of necessary drugs which enter a country.

The recent trend in intellectual property protection has been towards a more uniform system at the international level (Phillip McCalman 2001; Mark S. Massel 1973; Gene M. Grossman 1991). McCalman (2001) discusses how this trend has led to transfers of wealth to the United States, which has historically had higher levels of IPR protection. The Federal Reserve Bank of San Fansisco's *FRBSF Economic Newsletter* (Diego Valderrama 2004) discusses how such transfers of wealth have led to some tension between relatively developed and relatively undeveloped countries.

To understand and possibly resolve this tension, it is necessary to understand how intellectual property protection systems affect various aspects of an economy, and whether the net effect on economic growth is positive or negative.

3. *Previous Research on Intellectual Property and Economic Growth*

Several authors have described relationships between intellectual property and certain measures of economic health (Griliches 1990; Grossman 1991; Gallini 2002; McCalman 2001). As a group, these authors show an indirect chain of events that should lead to the technological growth necessary for continuous economic expansion under New Growth Theory. For example, Gallini (2002) anecdotally links the relationship between intellectual property protection and the number of patents; and Griliches (1990) uses the number of patents as a reflection of innovation.

There are two main strands of empirical research concerning intellectual property and economic growth, stemming from two separate sources of data. The first uses patent data as a measure of technological growth, following the example of Zvi Griliches (1990).

A second source of data is an index developed by Juan C. Ginarte and Walter G. Park (Ginarte and Park 1997; Park and Ginarte 1997; Park 2001). It is known as the Ginarte-Park index, and used by many other researchers as well (Martin Falk 2004; Peter Nunnenkamp and Julius Spatz 2003). The Ginarte-Park index divides intellectual property protection into several categories, assigning one point for each category. The categories include patent length, treaty participation, scope of patent coverage, and enforcement of patent-rights in court. Other indexes have been developed, each with its own benefits and drawbacks (W. Lesser 2001).

The Ginarte-Park index measures treaty participation, patent length, the scope of patent protection, and the amount of patent enforcements in the courts. Each of these areas have one point each in the index, so subcategories have a fraction of a point.

Other papers do not include an econometric model. Michael Perlman (2003) gives a history of how stronger intellectual property protection actually has slowed the rate of technological progression, at least in specific areas. His examples focus on electronics, from the radio to the microchip.

The non-econometric papers which advocate stronger intellectual property often relate their arguments to finance. Some consider weak intellectual property protection as a deterrent to foreign direct investment. Others consider intellectual-property protection as a good source of endogenous growth, because firms within an economy will be more likely to finance research and development if their innovations are protected properly (Michael J. Mandel 2004; Massel 1973; Valderama 2004).

Empirical papers often show that intellectual property protection has a positive effect. Lesser (2001) and the literature he reviews show that intellectual property protection has a positive effect on foreign direct investment. Falk (2004) lists patent rights as one of the many factors of research and development intensity, and finds that it has a positive effect.

Contrasting with previous research

Much of the existing research tends to look at the issue in the same ways, leading to similar results. Empirical researchers almost always find some positive effect of intellectual property protection. Unlike previous research which used foreign direct investment as the dependent variable (Beata Smarzynska Javorcik 2004; Nunnenkamp and Spatz 2003), this project uses economic growth as the dependent variable. The advantage is that it measures the total effect of the intellectual property system, instead of one component. The disadvantage is that the economy as a whole is very complex, and many other variables are also involved.

Theory

In this paper I hope to test the statistical significance of the Ginarte-Park intellectual property rights (IPR) index as a determinant of economic growth. To build a theoretical model, I will start with a restatement of New Growth Theory in my own words, and then I will show how intellectual property protection fits into the model.

New growth theory says that economic growth is a function of investment and technological growth. When technological growth is limited, economic growth is also limited, as the economy approaches a steady state.

Technological growth has two sources, one endogenous and the other exogenous. Endogenous technological growth originates only from innovations within an economic system, or in most cases within an individual nation. Some innovation is a result of investments in research and development. Other innovation comes as a result of non-market forces. Both of these types of endogenous innovation are benefited by the level of education.

Exogenous technological growth occurs as a result of incorporating technologies from other cultures. This can happen gradually, as a result of openness to foreign influences; or it can happen quickly, as a result of a modernization effort. Either way, the process first requires the ability to imitate and copy foreign products, machines, and manufacturing processes. This results in low cost, relatively low quality products. To advance further, a developing nation must develop an understanding of the products that it chooses to manufacture, as well as the machines and processes that are used.

Some of the knowledge that is necessary can be acquired over time through learning-by-doing. The rest can be acquired through targeted educational programs. In this way, education is tied to both exogenous and endogenous technological growth. The introduction of an intellectual property system changes all of this.

An intellectual property system rewards innovation and encourages more investment in research and development. By requiring a description of his or her invention, the intellectual property system promotes disclosure, especially from innovations that occur outside of research and development. In exchange for this disclosure, the system promises monopoly rewards. These monopoly rewards cause deadweight losses and other side effects.

The main effect of the intellectual property system is to create a marketplace for ideas. In other words, the presence of intellectual property laws formalizes the rules for the marketplace, and international agreements expand the marketplace beyond the borders of an individual country. An international marketplace for innovations increases the potential market for all innovations, thereby increasing both the incentive to innovate, but also increasing deadweight loss.

If foreign and domestic patents are treated equally, all innovation is treated as if it is endogenous. This reduces and regulates the amount of exogenous technological growth as defined in this study. With the addition of an intellectual property system, poor countries may no longer absorb foreign technology freely. If they wish to copy something which is protected by a patent, they must usually pay a royalty to the patent holder. This is good for the patent holder, but bad for those that live in the poor countries.

In the case of a developed country, exogenous technological growth will also be reduced. In both cases, the system of rewards is designed to promote endogenous technological growth, but since all innovations are treated equally, they are all treated as if they come from within the culture.

The effect of an intellectual property system will have both a positive component and a negative component. The primary effect will be to increase investment in research and development, both at home and abroad. This is the positive component. The secondary effect will be to limit the availability of recent innovations. Both effects will be stronger if there is more education and investment capital available.

On the positive side, intellectual property systems create more demand for higher education to be used in research and development. On the negative side, firms often use a portion of their resources to reengineer and recreate innovations already in the marketplace, to avoid paying high royalties (Yum K. Kwan and Edwin L.-C. Lai 2003).

In other words, the intellectual property system uses education and other resources inefficiently, but at least we could say that more people are pursuing education and conducting research. Even though there are positive externalities associated with both research and education (Lucas 1988), the externalities from research mainly affects the countries in which the research takes place (Grossman 1991). For developing countries, most of the research is occurring outside of their boarders, so this externality does not affect them.

On the negative side, the intellectual property system limits the use local investment resources. It prevents manufacturers from making products which are simply copies and imitations of existing products. This limits the availability of low cost, low quality products. The availability of these low cost, low quality products does not substantially affect the quality of life in developed nations, but for developing nations, it can be very important. For poor and developing countries, copying foreign technology is not only a morally acceptable solution, but in some cases the most efficient step forward in the path towards development. As an economy develops, copying rather than innovating becomes both morally unacceptable and less practical, as consumers demand better and better products.

On the positive side, this protects both the foreign investor and the investor that has put a lot of resources into the creation of a certain product. By protecting the rights of foreign investors, an intellectual property system promotes foreign direct investment (FDI). The effects of FDI should be stronger in countries that have IP systems that are similar to the advanced western markets.

The net effect of an intellectual property system is the sum of these positive and negative effects listed above. Education, investment, and the strength of intellectual property protection all interact to produce technological growth, but the strength of intellectual property protection limits the widespread availability of such technology. By including a variable to represent the strength of intellectual property protection, one can find out whether the net effect of intellectual property protection on economic growth is positive or negative.

Model

The goal of this part of the paper is to test the effect of intellectual property protection on economic growth, using the Ginarte-Park intellectual property rights (IPR) index. To do this, we need to start with a reasonable model that does not include the intellectual property rights index, and later add the index to the model.

I used the growth rate in the real GDP per capita between 1990 and the end of 1994 ("GRWB7") as my dependent variable. ("GRWB7" is the name of the variable from the Barro-Lee data set.)

An educational attainment variable from 1990 was chosen based on its relative ability to model economic growth in a single variable model. "LSM90" seemed to be the strongest of the educational attainment variables from the Barro-Lee data set. "LSM90" refers to high school attainment in the male ("M") population 25 years or older.

For convenience, the education has been renamed as "School_1990". I would rather use an index for educational attainment than a single variable, but constructing an index results in reducing the number of usable observations. By itself, school attainment is able to predict .079 of the variation in growth rates. Table 1 shows that higher graduation rates among males in 1990 are associated with higher economic growth between 1990 and 1994. The effect is statistically significant at the 1% level.

Table 1: Preliminary Model Development		
	Step 1	Step 2
Intercept	0.0048	-03.65
	(.01)	(-4.43)
School_1990	0.0597	0.0523
	(2.9)	(2.9)
Invest95	--	0.174
	--	(5.49)
R^2	.079	.3095
Observations Used	100	99

Next, I added a variable for investment which occurred between the beginning of 1990 and the end of 1994. The "INVWB7" investment variable was chosen from the Barro-Lee data set, because it is calculated similarly to the economic growth variable. For convenience, I refer to this variable as "Invest95," because it shows the amount of investment in the five year period ending just before the first day of 1995. Table 1 shows the first and second steps in developing the model. Including the investment variable increases the R^2 figure to around 30%.

As a final step, we can now add the Ginarte-Park intellectual property rights index ("IPR_1990") to the model. This index was produced by Ginarte and Park. The index reflects what types of patents are covered, treaty participation, whether a patent can lose its power under certain conditions, the enforcement of patents in courts, and patent length. Each of these categories is worth one point in the index. Higher values in this index reflect stronger patent protection.

The IPR data is available in five year intervals starting in 1965. A recent update of the data included 1995 values and included several additional countries. The additional countries were ones that have recently started to embrace a market-oriented economy, such as China and the Czech Republic. A cross-sectional study seemed good because the data values for each country were relatively stable over time (see Table 10). 1990 seemed to be a good choice for the IPR data because the data values were relatively new and were part of the original study.

Table 2 describes the distribution of this variable. The column on the right is based on the 90-country sample used in this study, which is limited due to missing data in other categories. Countries that had missing data tended to have lower IPR scores.

Table 2: Distribution of the intellectual property rights index

Quantile	Distribution of IPR index in 1990	Distribution of IPR index in 1990, Limited Sample
Max	4.52	4.52
Q3	3.01	3.16
Median	2.52	2.57
Q1	1.90	1.98
Min	0	0.33
Variance	.919	0.726

The IPR index assigns one point in each of the five categories. No countries received a perfect score. Several countries received zeros from 1965 to 1990 (Angola, Mozambique, Myanmar, Papau New Guinea, and Ethiopia). Of these, only two (Angola, Papau New Guinea) were included in the study, because of missing data in other categories. The United States received the highest score in 1990, as well as most other years covered by the index.

Table 3: Variable Descriptions		
Variable	Original variable name	Description
Growth95	GRWB7	Economic growth rate, from 1990 to 1995; Converted to a percentage
School_1990	LSM90	High school attainment rate in adult male population, 1990
Invest95	INVWB7	Average investment as a proportion of GDP, from 1990 to 1995; Converted to a percentage
IPR_1990	--	Ginarte-Park Intellectual Property Right (IPR) index in 1990
IPR_xxxx	--	Ginarte-Park Intellectual Property Right (IPR) index in another year
GDP85	RGDPL85	Real gross domestic product (GDP) per capita in the year 1985, from Barro-Lee data set. (Variable has been scaled by dividing it by 100,000.)
Growth90	GRWB6	Economic growth rate, from 1985 to 1990; Converted to a percentage

Table 3 summarizes the meaning of the basic variables to be used in the models in this paper. The original variable names have been included (where possible) so that my research can be replicated.

Model 1: Economic growth modeled on high school attainment, recent investment, and an intellectual property protection index
Growth95 = -1.49 + .0791 School_1990 + 0.199 Invest95 – 1.33 IPR_1990 (-1.37) (3.95) (5.26) (-4.22)
Observations Used: 90 R^2: .4669

Model 1 is a good basic model, and shows the relationship between economic growth, investment, and intellectual property protection. Each of the variables is significant well below the 1% level of significance. The other two variables maintain their positive coefficient, so the model does have some good explanatory power. The R^2 value is now about .47, so it explains a little less than half of the variation in growth rates. 90 observations were used in this model.

The negative coefficient for the intellectual property rights index is unexpected, and is an interesting finding. In this project I was initially expecting to obtain either a significantly positive or an insignificant coefficient for the intellectual property rights variable. A positive value would have shown that the results of stronger intellectual property protection, as measured by this index, results in more economic growth. It would have shown that the effects of the increased incentives to innovate are stronger than the deadweight loss resulting from increased patent protection. This negative coefficient shows that stronger intellectual property protection is statistically associated with slower economic growth. For many countries, the negative effects of patent protection, including deadweight loss, seem to be outweighing the positive effects.

An important issue is whether convergence plays a role in the model. The theory of convergence says that countries that are relatively more advanced should grow more slowly than countries that are less advanced. It mainly applies to countries that are experiencing rapid growth as a result of modernization efforts. As their GDP capita approaches the level of the leading economies, their growth rate slows down. Countries with stronger economies also tend to have stronger intellectual-property systems. If convergence is an issue, then Model 1 can be called into question, because it does not include a GDP per capita variable. I don't know whether countries with stronger IPR values are growing slower because of deadweight loss from IPR protection, or whether they are growing relatively slower because of the effects of convergence.

Model 2: Using a static GDP variable to control for convergence
Growth95 = -1.43 + .071 School_1990 + .201 Invest95 – 1.38 IPR_1990 (-1.3) (2.79) (5.27) (-4.21) + 4.208 GDP85 (0.52)
Observations Used: 90 R^2: .4686

In Model 2 the t-value for the GDP per capita variable is .52, which is positive and statistically insignificant. If convergence is a major issue, the coefficient would be negative and statistically significant. During this five year period, and among the limited sample, the economies of most countries are not observed to be converging.

Instead of demonstrating convergence, Model 2 suggests that countries that have strong economies grow slightly faster on average than countries that have weak ones. This is not a statistically significant finding at the 10% level of significance, or the focus of the paper. The low t-value of .52 suggests that random error is about twice as much as the coefficient. More importantly, the coefficient of the IPR variable is still negative and statistically significant at the 1% level of significance, when the static GDP variable is included.

As noted earlier, the 1990 IPR data does not include the transitional economies that were later added to the data. If the focus of the paper is to prove or disprove convergence, it would be beneficial to use the 1995 IPR data and include the transitional economies. I also would need to develop a different sort of model, which would explain and quantify the advantages that higher income societies have in terms of producing economic growth. This would show whether a well developed IPR system is one of the advantages of a high income society.

The biggest advantage higher income societies have is their ability to reinvest their income in growth-engendering areas such as education. The coefficient that changes the most between Model 1 and Model 2 belongs to the education variable. Some of the economic growth that is attributed to the education variable in Model 1 is being attributed to the initial per capita income variable in Model 2.

The discussion above implies that there is a relationship between the education variable, the static GDP variable, and the potential for GDP growth. There doesn't appear to be a similar relationship between the IPR variable and the static GDP variable. More importantly, the coefficient of the IPR variable changes only slightly when the GDP per capita variable is added. The coefficient of the investment variable is affected even less, though it is not the variable being studied.

An idea similar to the idea of convergence is the idea that an economy will continue to grow at a similar rate to which it is currently growing. To put this differently, economic growth will follow a trend, and the trend will usually change gradually. This trend can be affected by many factors. Some economies are stagnating, or shrinking, because of an internal problem, but the problem can be different in each country. Instead of labeling each problem, and trying to find data, it is easier to just declare that there is a trend. Models 3 and 4 include a lagged economic growth variable, so that this trend is taken into account.

Model 3: Including a lagged growth variable instead of a static GDP variable
Growth95 = -.494 + .068 School_1990 + .155 Invest95 – 1.35 IPR_1990 (-.44) (3.38) (3.78) (-4.4) + .231 Growth90 (2.44)
Observations Used: 90 R^2: .5017

All variables in Model 3 are significant at the 1% level of significance. The lagged GDP growth variable has a positive coefficient, and shows that historical growth is positively associated with current growth. Model 4 adds the initial GDP per capita variable back in, in order to account for both the recent growth trend and any convergence effect.

Model 4: Including a lagged growth variable along with a static GDP variable
Growth95 = -.457 + .062 School_1990 + .157 Invest95 – 1.38 IPR_1990 (-.4) (2.47) (3.79) (-4.35) + 3.11 GDP85 + .228 Growth90 (.39) (2.4)
Observations Used: 90 R-Squared value: .503

Again, in Model 4 only the static GDP variable is insignificant. Adding this variable to Model 3 does not change the t-value of the IPR variable by very much. The education variable is affected more, especially the t-value.

Models 1-4 do not have any problems with multicollinearity or heteroschedasticity. Model 4's highest collinearity diagnostic is 14. For each of the other models, the highest collinearity diagnostics are 11.74, 12.84, and 12.88, respectively. The Chi-squared value associated a heteroschedastity test on Model 4 is 18. Models 1, 2, and 3 have Chi-squared statistics of 7.29, 11.76 and 13.3, respectively.

In the next table, Model 4 is compared to a few simplified models that include the intellectual rights index. T-values are shown in parenthesis.

Table 4: Several simplified models compared with Model 4

	A	B	C	Model 4
Intercept	2.93 (4.09)	-0.494 (-0.45)	2.96 (3.95)	-.457 (-.4)
School_1990	-- --	-- --	0.0839 (3.2)	.062 (2.47)
Invest95	-- --	0.158 (3.98)	-- --	.157 (3.79)
IPR_1990	-1.174 (-3.74)	-1.028 (-3.48)	-1.651 (-4.95)	-1.38 (-4.35)
GDP85	15.21 (2.28)	14.44 (2.32)	-0.172 (-0.02)	3.11 (.39)
Growth90	0.442 (5.13)	0.248 (2.63)	0.388 (4.23)	.228 (2.4)
R^2	.314	.411	.270	.501
Observations Used	102	102	97	90

From Table 4 we can conclude that the short term effect of intellectual property rights protection seems to be negative. When the model accounts for investment and educational attainment, countries that have high rates of intellectual property protection are predicted, on average, to have lower rates of growth. When the model does not account for either investment or educational attainment, or both, countries that have high rates of intellectual property protection are still predicted to have lower rates of growth. In contrast, the coefficient of the static GDP variable is only significant when the education variable is not in the model. (The investment variable has a similar effect on the intercept coefficient.)

Table 5 displays the correlation statistics between the variables. The correlation is relatively high between the GDP per capita variable (GDP85) and the education variable (School_1990) is quite high, leading to some multi-collinearity when both are included in the same model. There is also some correlation between IPR and GDP per capita and between IPR and education.

In Table 5, the education variable is positively correlated with both the initial GDP per capita, and the economic growth in the two successive 5 year periods. Perhaps there is a circular relationship between initial real GDP per capita, educational attainment, and economic growth rates.

Countries that have strong economies also value education. As their income continues to increase, more resources can be spent on education. With an adequate level of education, a country can absorb technology from other countries. Countries with relatively advanced educational systems will have the ability to shift the technological frontier. They can also absorb and reproduce technologies that originate from other high tech countries, as long as their educational systems stay up to date.

Table 5: Pearson Correlation Coefficients						
	Growth95	School_ 1990	Invest95	IPR_1990	GDP85	Growth90
Growth95	1	0.25487	0.53846	-0.09362	0.15004	0.46399
		0.0148	<.0001	0.3421	0.1284	<.0001
	105	91	104	105	104	102
School_ 1990	0.25487	1	0.25885	0.5131	0.73832	0.34455
	0.0148		0.0127	<.0001	<.0001	0.0008
	91	95	92	95	95	92
Invest95	0.53846	0.25885	1	0.01001	0.12837	0.53267
	<.0001	0.0127		0.9185	0.1897	<.0001
	104	92	107	107	106	104
IPR_1990	-0.09362	0.5131	0.01001	1	0.52903	0.10525
	0.3421	<.0001	0.9185		<.0001	0.2852
	105	95	107	110	109	105
GDP85	0.15004	0.73832	0.12837	0.52903	1	0.24362
	0.1284	<.0001	0.1897	<.0001		0.0123
	104	95	106	109	109	105
Growth90	0.46399	0.34455	0.53267	0.10525	0.24362	1
	<.0001	0.0008	<.0001	0.2852	0.0123	
	102	92	104	105	105	105

In Table 5, note that the IPR variable from 1990 has a weak negative correlation with the growth in the period from 1990 to 1995, but a weak positive correlation with growth in the period from 1985 to 1990. This information should be interpreted according to the time in which it takes place. The growth from 1985 to 1990 precedes the level of intellectual property protection in 1990. Perhaps countries are more likely to implement or maintain a stronger IPR system if they already have a strong economy. Then, the stronger IPR system causes the country's growth rate to slow down slightly.

To further test this model, I introduce a few interaction terms. Table 6 defines interaction terms between IPR, investment, and education.

Table 6: Definition of interaction terms
IPR_Invest = IPR_1990 * Invest95
IPR_School = IPR_1990 * School_1990

The most important term here is the interaction between the IPR index and the education variable. Education, combined with intellectual property protection, should result in more patentable innovations, and therefore more economic growth. The negative side effects may also be stronger, even at higher levels of education. If the overall effect of intellectual property protection is positive, then the interaction between education and IPR should also be positive. However, the models above show intellectual property protection to have a negative effect on economic growth.

The next model tests whether an exception to this rule exists. Some countries may be affected negatively by IPR, and others positively, based on different levels of education or investment. If the effect of IPR can be shown to vary according to such factors, then it would be reasonable for different countries to implement different intellectual property systems, according to their situation.

Table 7 introduces these interaction variables into models. The models show that the interaction variables listed above are not significant. The T-values, shown in parenthesis, are both less than 1 in absolute value. None of these values are significant at the 10% level of significance. Adding either of these variables does not increase appreciably the R^2 value.

Table 7: Interaction between IPR and education and investment		
	Interaction Model 1	Interaction Model 2
Intercept	-0.720 (-.48)	-0.820 (-.3)
School_1990	0.076 (1.32)	0.063 (2.44)
Invest95	0.156 (3.74)	0.174 (1.43)
IPR_1990	-1.286 (-2.67)	-1.244 (-1.22)
GDP85	3.548 (.44)	2.922 (.36)
Growth90	0.230 (2.4)	0.229 (2.39)
IPR_School	-0.00478 (-.27)	- -
IPR_Invest	- -	-0.66502 (-.15)
R^2	0.5031	0.5028
Observations Used	90	90

We can conclude that none of these interaction variables add much to the model. A negative interaction appears to exist between IPR and schooling, and between IPR and investment, although neither is statistically significant. Removing these interaction variables from the model returns us to the model which was discussed previously in this paper..

Table 8 divides the sample into two groups, based on IPR protection level. Countries with an IPR value less than or equal to the median are assigned to group A, while countries with IPR greater than the median are put in group B. Comparing the two groups, I anticipate a stronger negative correlation between increased IPR and economic growth in group B, because countries in this group have IPR protection that is already too strong, based on previous models.

Table 8: Comparing the marginal effect of intellectual property on two groups of countries. One group has low levels of intellectual-property protection, and the other has relatively high levels of intellectual property protection.		
	Group A (IPR <= 2.52)	Group B (IPR > 2.52)
Intercept	-1.342	-1.389
	(-.87)	(-.57)
School_1990	0.120	0.022
	(2.77)	(.7)
Invest95	0.183	0.109
	(3.4)	(1.76)
IPR_1990	-1.235	-0.652
	(-2.21)	(-.89)
GDP85	-20.021	7.324
	(-1.1)	(.79)
Growth90	0.055	0.476
	(.44)	(3.34)
R^2:	.45	.56
Observations Used:	44	46

Table 8 shows that the intellectual property rights variable has a much smaller effect in group B, compared to Models 1 though 4. Group A also has a smaller coefficient for this variable, compared to Models 1 through 4, but not as small as in Group B. The IPR variable in Group A is significant at the 10% level, and also at the 5% level. In Group B, IPR is not significant at either level. These findings suggest that Group A countries should not increase intellectual property protection but does not suggest that Group B countries should reduce IPR protection.

Table 9: More details on Model 4				
Variable	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	-0.45717	1.13917	-0.4	0.6892
School1990	0.0619	0.02504	2.47	0.0154
Invest95	0.15693	0.04145	3.79	0.0003
IPR_1990	-1.38388	0.31828	-4.35	<.0001
GDP85	3.112	7.91271	0.39	0.6951
Growth90	0.22842	0.09524	2.4	0.0187
R^2				.5027
Observations Used				90

This paper's models imply that an increase in intellectual property protection should decrease the amount of economic growth per capita. The data that was used to generate the models shows that most countries kept their intellectual property protection relatively stable. Some countries increased the level of protection one year, but then they would keep the level of protection constant for the next 5, 10, or 15 years. Very few countries decreased their level of intellectual property protection, and none of them eliminated it completely in a certain year.

Table 10: Changes in IPR protection, between each of the five year observations in the Ginarte-Park index. Counts are based on the 90 observations used in Models 1-4.

Time Period	1960-1965	1965-1970	1970-1975	1975-1980	1980-1985	1985-1990	1990-1995
Increases	23	31	6	34	13	9	47
Decreases	1	7	2	5	2	4	1

Models 1 through 4 use the IPR index from 1990 as the independent variable. In 1990, only nine countries had higher values in the IPR index then they had in 1985, and four countries had lower values than they did in 1985. The remaining 77 countries had the same values in 1990 as they did in 1985. Between 1980 and 1985, 15 countries either increased or decreased their IPR protection, while the remaining 75 countries in the sample maintained their IPR protection level.

A majority of the countries did not change their IPR protection, at least in a way that affects the index value, between 1980 and 1990. Others changed, but often only by a small amount. So, the use of the "IPR_1990" variable to help model per capita growth between 1990 and 1995 does not separate the short term effect on growth from the long term effect.

Conclusion

The various models consistently show that intellectual property protection is negatively correlated with economic growth. This finding contradicts previous empirical research, and suggests a new path for the development of intellectual property rights.

The models can be used to promote reductions in intellectual property protection, but only with some cautions. Most countries in the data set kept their intellectual property systems the same over long periods of time. Among those that changed their level of intellectual property protection, more increased the level over time, but usually very slowly. Even so, the models demonstrate that an individual country can lose by strengthening its intellectual property system. Once an intellectual property system is developed, or once it is strengthened to a certain level, an expectation is created that the system will remain in place for a long time.

While broad changes are not recommended, small periodic adjustments are necessary to keep the various intellectual property institutions relevant. The example I gave relates to computer technology, but other situations will arise which require a reaction from policy makers in the government. These adjustments should be accompanied by decreases rather than increases in intellectual property protection. This may cause inventors to get less economic rent from individual inventions, but over time it will lead to higher economic growth rates.

Another word of caution is that the models test the effect of intellectual property systems on an average individual country, not all countries as a group, and not any particular country. The optimal solution should be different in every country, depending on the current level of development, especially the level of education. The use of an index in this paper prevented me from studying individual issues, such as patent length and participation in international intellectual-property agreements.

When negotiating multilateral trade agreements, the United States should allow some countries to set their own level of intellectual property protection. Some countries are both too poor to pay for technologies imported from abroad. Other countries are at a level of development where they cannot generate many innovations on their own, regardless of the existence of an intellectual property system.

Once a country reaches a certain level of development, it is able to contribute to the generation of new ideas and technology. Therefore, the United States should try to negotiate so that each country will contribute as it is able.

The intellectual property system is currently the primary way governments encourage innovation and technological growth. This paper shows that the system has strong side effects for the individual country. In conducting trade negotiations, a few countries may therefore be unwilling to strengthen their protection of intellectual property. This is acceptable, as long as they are willing to develop their own method for encouraging innovation.

Such changes in intellectual property law should never be retroactive, of course. That would be fraudulent. The inventions in the recent past were made to receive certain rewards, so the reward structure for those should be maintained as long as the existing law promised they would be maintained.

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Appendix 1

The following table shows the data values for all countries that had Ginarte-Park IPR data available in 1990. The left-most column is the truncated country name as it appears in my data file. Many countries have two commonly-used names, which made merging the data more difficult. The second column is the three-letter abbreviation assigned to the country by the World Bank. The other six columns contain the variables that were used in the models, as defined in Table 3.

Country Name (Truncated)	World Bank Code	Growth 95	Growth 90	School_ 1990	Invest 95	GDP85	IPR_1990
ANGOLA	AGO	-6.33	.	.	15.58	0.00711	0
ARGENTIN	ARG	4.59	-1.17	26.2	16.7	0.05324	2.26
AUSTRALI	AUS	2.32	1.09	40.8	20.66	0.13583	3.32
AUSTRIA	AUT	1.15	2.59	69.2	24	0.11131	4.24
BURUNDI	BDI	-4.34	0.77	3.5	14.04	0.00527	2.86
BELGIUM	BEL	0.88	2.85	32.7	18.69	0.11285	3.9
BENIN	BEN	1.32	-2.53	14	14.72	0.01108	2.86
BURKINA	BFA	0.99	0.37	.	20.3	0.00495	2.24
BANGLADE	BGD	2.76	1.81	21.9	18.89	0.01216	1.99
BOLIVIA	BOL	1.66	-0.8	19.6	15.15	0.01754	1.98
BRAZIL	BRA	1.65	0.04	8.7	20.37	0.04017	1.85
BOTSWANA	BWA	1.49	5.55	14.3	28.86	0.02337	1.9
CENTRAL	CAF	-1.1	-1.88	11.9	11.75	0.0063	2.57
CANADA	CAN	0.24	1.72	32.2	18.61	0.15589	2.76
SWITZERL	CHE	-1.01	2.02	53.4	23.48	0.14864	3.8
CHILE	CHL	6.97	4.3	34.3	24.41	0.03467	2.41
IVORY CO	CIV	-1.27	-5.54	.	8.36	0.01545	2.52
CAMEROON	CMR	-4.51	-5.5	9.9	16.13	0.01487	2.57
CONGO	COG	-2.3	-3.74	30	28.41	0.02697	2.57
COLOMBIA	COL	2.67	2.66	17.7	19.23	0.02968	1.12
COSTA RI	CRI	2.56	2	10.7	27.57	0.03184	1.47
CYPRUS	CYP	.	5.52	37.6	25.61	0.06486	2.24
GERMANY	DEU	0.88	.	.	22.57	.	3.71
DENMARK	DNK	1.78	1.41	56.8	14.99	0.12969	3.9
DOMINICA	DOM	2.27	-0.06	11.5	24.3	0.02111	2.41
ALGERIA	DZA	-2.08	-2.76	11.6	30.25	0.02988	3.38
ECUADOR	ECU	1.23	-0.71	10.4	20.19	0.02913	1.54
EGYPT	EGY	1.3	0.48	21.7	20.19	0.01953	1.99
SPAIN	ESP	1.15	4.18	28.4	22.5	0.07536	3.62
ETHIOPIA	ETH	0.82	0.12	.	12.06	0.00299	0
FINLAND	FIN	-0.91	3.03	49.4	19.06	0.12051	2.95
FIJI	FJI	0.89	2.52	34.1	14.65	0.03281	2.01
FRANCE	FRA	0.61	2.37	39.9	19.75	0.12206	3.9
GABON	GAB	0.43	-3	.	22.98	0.04072	2.57
UNITED K	GBR	0.96	2.84	35.2	16.29	0.11237	3.57
GHANA	GHA	1.48	1.25	30.6	17.86	0.00792	2.9
GREECE	GRC	1.01	1.19	34.2	21.17	0.06224	2.32
GRENADA	GRD	0.73	6.17	.	34.48	0.01873	1.7

Country Name (Truncated)	World Bank Code	Growth 95	Growth 90	School_ 1990	Invest 95	GDP85	IPR_1990
GUATEMAL	GTM	1.61	0	6	15.83	0.0209	1.08
GUYANA	GUY	6.35	-2.1	30.6	24.68	0.01265	1.42
HONG KON	HKG	3.78	6.68	46.9	28.51	0.10599	2.57
HONDURAS	HND	0.61	-0.01	9.5	28.94	0.01387	1.76
HAITI	HTI	-4.99	-2.95	12.8	7	0.00911	3.19
INDONESI	IDN	6.03	4.2	21.4	29.49	0.01651	0.33
INDIA	IND	3.49	3.87	19.8	22.79	0.0105	1.48
IRELAND	IRL	5.34	4.91	41.9	17.22	0.07275	2.99
IRAN	IRN	2.86	-5.16	24.8	30.14	0.04043	2.38
IRAQ	IRQ	.	-15.88	20.3	.	0.04249	2.46
ICELAND	ISL	-0.32	1.82	36.5	17.08	0.12209	2.12
ISRAEL	ISR	2.99	2.17	35.1	24.93	0.0831	3.57
ITALY	ITA	0.96	2.84	35.2	19.07	0.10808	4.05
JAMAICA	JAM	0.09	3.19	27.8	31.04	0.02215	2.86
JORDAN	JOR	2	0.18	23.8	32.83	0.03561	1.86
JAPAN	JPN	1.12	4.02	41.5	30.72	0.11771	3.94
KENYA	KEN	-1.25	1.92	10.6	19.98	0.00794	2.57
KOREA	KOR	6.46	8.66	57.6	36.71	0.04217	3.94
LIBERIA	LBR	.	.	16	.	0.00853	2.19
SRI LANK	LKA	4.05	1.78	37.7	24.39	0.02045	3.12
LUXEMBOU	LUX	4.01	3.76	.	22.81	0.13175	3.05
MOROCCO	MAR	-0.71	1.67	.	22.99	0.01956	2.38
MADAGASC	MDG	-2.89	-0.4	.	11.76	0.00769	1.86
MEXICO	MEX	-0.21	-0.42	23.6	22.5	0.05621	1.63
MALI	MLI	0.51	1.45	3.9	19.72	0.00532	2.57
MALTA	MLT	4.27	5.33	35.3	30.56	0.05321	1.89
MYANMAR	MMR	.	.	18.8	13.41	0.00599	0
MOZAMBIQ	MOZ	1.2	1.3	2.5	15.95	0.00749	0
MAURITAN	MRT	1	0.2	6.1	19.26	0.00824	2.57
MAURITIU	MUS	3.7	7.56	37.3	30.38	0.04226	2.89
MALAWI	MWI	0.35	-0.69	7.4	20.87	0.00518	3.24
MALAYSIA	MYS	6.05	4.24	33.7	36.37	0.04146	2.37
NIGER	NER	-2.48	-1.5	2	7.76	0.00559	2.24
NIGERIA	NGA	-0.4	1.64	.	20.58	0.01062	3.05
NICARAGU	NIC	-1.23	-5.62	8.1	19.87	0.0179	0.92
NETHERLA	NLD	1.43	2.14	45.7	20.35	0.11539	4.24
NORWAY	NOR	3.12	0.56	71.7	21.85	0.14144	3.29
NEPAL	NPL	2.64	1.96	13.3	21.19	0.00936	2.52
NEW ZEAL	NZL	1.72	-0.17	20.4	18.98	0.11443	3.32
PAKISTAN	PAK	2.28	2.49	21.3	16.15	0.01262	1.99
PANAMA	PAN	3.61	-3.57	28.2	20.87	0.03499	2.41
PERU	PER	4.62	-3.85	25.3	18.98	0.02565	1.02
PHILIPPI	PHL	-0.12	2.14	29.1	22.75	0.01542	2.67
PAPUA NE	PNG	5.64	-1.34	7.7	21.92	0.01619	0
PORTUGAL	PRT	1.7	4.96	17	25.65	0.0507	1.98
PARAGUAY	PRY	0.53	0.89	21.7	21.72	0.02072	1.8

Country Name (Truncated)	World Bank Code	Growth 95	Growth 90	School_ 1990	Invest 95	GDP85	IPR_1990
RWANDA	RWA	-3.38	-3.6	2.5	12.41	0.00776	2.86
SAUDI AR	SAU	-0.89	0.1	.	21.46	0.08313	2.05
SUDAN	SDN	6.73	.	8.2	.	0.00791	3.52
SENEGAL	SEN	-1.09	0.47	6.1	14.36	0.01163	2.57
SINGAPOR	SGP	6.5	5.94	31.9	35.33	0.08616	2.57
SIERRA L	SLE	-7.05	-0.18	7.2	8.76	0.00905	2.52
EL SALVA	SLV	4.03	0.17	9.9	17.24	0.01831	2.19
SOMALIA	SOM	.	-1.9	.	15.5	0.00653	1.8
SWEDEN	SWE	-0.12	1.57	45.1	16.63	0.13451	3.9
SWAZILAN	SWZ	-0.48	4.35	18.1	25	0.02198	2.19
SYRIA	SYR	4.24	0.18	19	22.5	0.0424	2.46
CHAD	TCD	3.77	0.14	.	11.33	0.00409	2.71
TOGO	TGO	-2.56	-1.1	18.7	15.49	0.00637	2.24
THAILAND	THA	7.14	7.9	9	40.87	0.02463	1.85
TRINIDAD	TTO	0.9	-3.69	32.3	15.45	0.09701	3.01
TUNISIA	TUN	2.02	1.11	18.4	27.2	0.02758	1.9
TURKEY	TUR	1.43	3.58	15.4	24	0.03077	1.8
TANZANIA	TZA	-0.66	1.21	.	25.32	0.00473	2.9
UGANDA	UGA	3.7	1.84	14.5	14.73	0.0054	2.57
URUGUAY	URY	3	3.01	23.9	13.22	0.03969	2.26
UNITED S	USA	1.05	1.61	33.7	16.32	0.1657	4.52
VENEZUEL	VEN	1.17	0.09	11.9	17.11	0.06225	1.35
SOUTH AF	ZAF	-1.25	-0.85	21.6	15.77	0.03322	3.57
ZAIRE	ZAR	-10	-2.54	15.5	6.24	0.00442	2.86
ZAMBIA	ZMB	-2.91	-1.86	19.4	13.76	0.00808	3.52
ZIMBABWE	ZWE	-1.6	0.2	26	20.73	0.01216	2.9

Appendix 2

The following table shows the values for the Ginarte-Park IPR index, for all countries that there is data available. The country names are in the first column, in a truncated form, as they appear in my data file. The second column contains the three letter code assigned to the country by the World Bank. The other eight columns contain the Ginarte-Park index data, with the variable names broken up into two lines. The variable IPR_1960, for example, refers to the index value in 1960. Countries with missing data between 1960 and 1990 were referred to as transitional economies.

Country Name (Truncated)	World Bank Code	IPR_ 1960	IPR_ 1965	IPR_ 1970	IPR_ 1975	IPR_ 1980	IPR_ 1985	IPR_ 1990	IPR_ 1995
ANGOLA	AGO	0	0	0	0	0	0	0	1.65
ARGENTIN	ARG	1.93	1.93	2.26	2.26	2.26	2.26	2.26	3.19
AUSTRALI	AUS	2.9	2.9	2.9	2.9	3.23	3.23	3.32	3.86
AUSTRIA	AUT	3.38	3.38	3.48	3.48	3.81	3.81	4.24	4.57
BURUNDI	BDI	2.52	2.52	2.52	2.52	2.86	2.86	2.86	2.86
BELGIUM	BEL	3.05	3.38	3.38	3.38	3.38	4.05	3.9	3.9
BENIN	BEN	2.05	2.05	2.52	2.52	2.52	2.52	2.86	2.86
BURKINA	BFA	1.76	2.1	2.24	2.24	2.24	2.24	2.24	2.57
BANGLADE	BGD	1.99	1.99	1.99	1.99	1.99	1.99	1.99	2.32
BULGARIA	BGR	.	.	.	.	.	.	.	2.57
BOLIVIA	BOL	2.12	2.12	1.98	1.98	1.98	1.98	1.98	2.31
BRAZIL	BRA	1.64	1.64	1.64	1.51	1.85	1.85	1.85	3.05
BOTSWANA	BWA	1.7	1.7	1.7	1.7	1.9	1.9	1.9	1.9
CENTRAL	CAF	1.76	2.1	2.24	2.24	2.57	2.57	2.57	2.57
CANADA	CAN	2.76	2.76	2.76	2.76	2.76	2.76	2.76	3.57
SWITZERL	CHE	2.38	2.71	3.14	3.14	3.8	3.8	3.8	3.91
CHILE	CHL	1.98	1.98	2.41	2.41	2.41	2.41	2.41	3.07
CHINA	CHN	.	.	.	.	.	.	.	1.55
IVORY CO	CIV	2.05	2.38	2.52	2.52	2.52	2.52	2.52	2.52
CAMEROON	CMR	1.76	2.1	2.24	2.24	2.57	2.57	2.57	2.57
CONGO	COG	1.76	2.1	2.24	2.24	2.57	2.57	2.57	2.57
COLOMBIA	COL	2.08	2.08	1.62	1.8	1.12	1.12	1.12	2.57
COSTA RI	CRI	2.19	2.19	1.76	1.76	1.94	1.47	1.47	1.8
CYPRUS	CYP	1.9	1.9	2.24	2.24	2.24	2.24	2.24	2.24
CZECH RE	CZE	.	.	.	.	.	.	.	3.19
GERMANY	DEU	2.33	2.66	3.09	3.09	3.86	3.71	3.71	3.86
DENMARK	DNK	2.33	2.66	2.8	2.8	3.62	3.76	3.9	4.05
DOMINICA	DOM	2.26	2.26	2.41	2.41	2.41	2.41	2.41	2.41
ALGERIA	DZA	3.05	3.05	3.38	3.38	3.38	3.38	3.38	3.38
ECUADOR	ECU	1.94	1.94	1.66	1.66	1.54	1.54	1.54	2.71
EGYPT	EGY	1.99	1.99	1.99	1.99	1.99	1.99	1.99	1.99

Country Name (Truncated)	World Bank Code	IPR_ 1960	IPR_ 1965	IPR_ 1970	IPR_ 1975	IPR_ 1980	IPR_ 1985	IPR_ 1990	IPR_ 1995
SPAIN	ESP	2.95	3.29	3.29	3.29	3.29	3.29	3.62	4.05
ETHIOPIA	ETH	0	0	0	0	0	0	0	0
FINLAND	FIN	1.99	1.99	2.14	2.14	2.95	2.95	2.95	4.19
FIJI	FJI	2.01	2.01	2.01	2.01	2.01	2.01	2.01	2.01
FRANCE	FRA	2.76	3.1	3.24	3.24	3.9	3.9	3.9	4.05
GABON	GAB	1.76	2.1	2.24	2.24	2.57	2.57	2.57	2.57
UNITED K	GBR	2.7	3.04	3.04	3.04	3.57	3.57	3.57	3.57
GHANA	GHA	2.23	2.23	2.37	2.37	2.9	2.9	2.9	2.07
GREECE	GRC	2.46	2.46	2.46	2.46	2.46	2.46	2.32	2.65
GRENADA	GRD	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7
GUATEMAL	GTM	1.94	1.94	1.08	1.08	1.08	0.75	1.08	1.08
GUYANA	GUY	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42
HONG KON	HKG	2.04	2.04	2.04	2.04	2.24	2.57	2.57	2.57
HONDURAS	HND	2.05	2.05	2.05	2.05	1.76	1.76	1.76	2.1
HAITI	HTI	3.19	3.19	3.19	3.19	3.19	3.19	3.19	3.19
HUNGARY	HUN	.	.	.	.	.	.	.	3.37
INDONESI	IDN	0.33	0.33	0.33	0.33	0.33	0.33	0.33	1.24
INDIA	IND	1.85	1.85	1.42	1.62	1.62	1.62	1.48	1.51
IRELAND	IRL	2.23	2.56	2.99	2.99	2.99	2.99	2.99	3.32
IRAN	IRN	2.38	2.38	2.38	2.38	2.38	2.38	2.38	2.38
IRAQ	IRQ	2.13	2.13	2.13	2.13	2.46	2.46	2.46	2.46
ICELAND	ISL	2.12	2.12	2.12	2.12	2.12	2.12	2.12	2.45
ISRAEL	ISR	3.04	3.37	3.57	3.57	3.57	3.57	3.57	3.57
ITALY	ITA	2.99	3.32	3.32	3.46	3.71	4.05	4.05	4.19
JAMAICA	JAM	3.09	2.86	2.86	2.86	2.86	2.86	2.86	2.86
JORDAN	JOR	1.52	1.52	1.52	1.86	1.86	1.86	1.86	2.19
JAPAN	JPN	2.85	3.18	3.32	3.61	3.94	3.94	3.94	3.94
KENYA	KEN	2.37	2.37	2.37	2.37	2.57	2.57	2.57	2.9
KOREA	KOR	2.8	2.8	2.94	2.94	3.28	3.61	3.94	4.2
LIBERIA	LBR	2.19	2.19	2.19	2.19	2.19	2.19	2.19	2.86
SRI LANK	LKA	2.6	2.6	2.6	2.6	2.79	3.12	3.12	3.12
LITHUANI	LTU	.	.	.	.	.	.	.	2.9
LUXEMBOU	LUX	2.29	2.29	2.71	2.71	3.05	3.05	3.05	3.05
MOROCCO	MAR	2.38	2.38	2.38	2.38	2.38	2.38	2.38	2.38
MADAGASC	MDG	1.05	1.38	1.52	1.52	1.86	1.86	1.86	2.27
MEXICO	MEX	1.7	1.7	1.99	1.99	1.4	1.4	1.63	2.86
MALI	MLI	1.9	1.9	1.9	1.9	1.9	2.57	2.57	2.57
MALTA	MLT	1.56	1.56	1.89	1.89	1.89	1.89	1.89	1.89
MYANMAR	MMR	0	0	0	0	0	0	0	0
MOZAMBIQ	MOZ	0	0	0	0	0	0	0	0
MAURITAN	MRT	1.76	2.1	2.24	2.24	2.24	2.57	2.57	2.57
MAURITIU	MUS	2.56	2.56	2.56	2.56	2.89	2.89	2.89	2.89
MALAWI	MWI	2.37	2.7	2.7	2.7	3.04	3.24	3.24	3.24
MALAYSIA	MYS	2.37	2.37	2.37	2.37	2.57	2.9	2.37	2.85
NIGER	NER	1.76	2.1	2.24	2.24	2.24	2.24	2.24	2.57
NIGERIA	NGA	2.71	3.05	3.05	3.05	3.05	3.05	3.05	3.05

Country Name (Truncated)	World Bank Code	IPR_ 1960	IPR_ 1965	IPR_ 1970	IPR_ 1975	IPR_ 1980	IPR_ 1985	IPR_ 1990	IPR_ 1995
NICARAGU	NIC	1.78	1.78	0.92	0.92	0.92	0.92	0.92	0.92
NETHERLA	NLD	2.95	3.29	3.61	3.47	4.24	4.24	4.24	4.38
NORWAY	NOR	2.66	2.66	2.8	2.8	3.29	3.29	3.29	3.9
NEPAL	NPL	2.52	2.52	2.52	2.52	2.52	2.52	2.52	2.52
NEW ZEAL	NZL	2.85	3.18	3.18	3.18	3.32	3.32	3.32	3.86
PAKISTAN	PAK	1.99	1.99	1.99	1.99	1.99	1.99	1.99	1.99
PANAMA	PAN	2.41	2.41	2.41	2.41	2.41	2.41	2.41	3.52
PERU	PER	1.17	1.17	1.31	1.31	1.02	1.02	1.02	2.71
PHILIPPI	PHL	2.19	2.52	2.67	2.67	2.67	2.67	2.67	2.67
PAPUA NE	PNG	0	0	0	0	0	0	0	0
POLAND	POL	.	.	.	.	.	.	.	2.9
PORTUGAL	PRT	1.98	1.98	1.98	1.98	1.98	1.98	1.98	2.98
PARAGUAY	PRY	1.8	1.8	1.8	1.8	1.8	1.8	1.8	2.8
ROMANIA	ROM	.	.	.	.	.	.	.	2.71
RUSSIAN	RUS	.	.	.	.	.	.	.	3.04
RWANDA	RWA	2.52	2.52	2.52	2.52	2.52	2.86	2.86	2.86
SAUDI AR	SAU	2.05	2.05	2.05	2.05	2.05	2.05	2.05	2.05
SUDAN	SDN	2.86	2.86	2.86	2.86	2.86	3.52	3.52	3.52
SENEGAL	SEN	1.76	2.1	2.24	2.24	2.24	2.57	2.57	2.57
SINGAPOR	SGP	2.37	2.37	2.37	2.37	2.57	2.57	2.57	3.9
SIERRA L	SLE	2.52	2.52	2.52	2.52	2.52	2.52	2.52	2.52
EL SALVA	SLV	2.19	2.19	2.19	2.19	2.19	2.19	2.19	2.86
SOMALIA	SOM	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8
SLOVAK R	SVK	.	.	.	.	.	.	.	3.19
SWEDEN	SWE	2.33	2.66	2.8	2.8	3.47	3.47	3.9	4.24
SWAZILAN	SWZ	2.19	2.19	2.19	2.19	2.19	2.19	2.19	2.86
SYRIA	SYR	2.46	2.46	2.46	2.46	2.46	2.46	2.46	2.46
CHAD	TCD	2.05	2.38	2.38	2.38	2.71	2.71	2.71	2.71
TOGO	TGO	1.9	1.9	2.24	2.24	2.24	2.24	2.24	2.57
THAILAND	THA	1.51	1.51	1.51	1.51	1.85	1.85	1.85	2.24
TRINIDAD	TTO	3.01	3.01	3.01	3.01	3.01	3.01	3.01	3.35
TUNISIA	TUN	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9
TURKEY	TUR	1.65	1.65	1.8	1.8	1.8	1.8	1.8	1.8
TANZANIA	TZA	2.7	2.7	2.7	2.7	2.9	2.9	2.9	2.9
UGANDA	UGA	2.04	2.37	2.37	2.37	2.57	2.57	2.57	2.9
UKRAINE	UKR	.	.	.	.	.	.	.	3.04
URUGUAY	URY	1.79	1.79	2.26	2.26	2.26	2.26	2.26	2.6
UNITED S	USA	3.86	3.86	3.86	3.86	4.19	4.52	4.52	4.86
VENEZUEL	VEN	1.35	1.35	1.35	1.35	1.35	1.35	1.35	2.9
VIETNAM	VNM	.	.	.	.	.	.	.	3.13
SOUTH AF	ZAF	3.04	3.37	3.37	3.37	3.57	3.57	3.57	3.57
ZAIRE	ZAR	2.52	2.52	2.52	2.86	2.86	2.86	2.86	2.86
ZAMBIA	ZMB	3.52	3.52	3.52	3.52	3.52	3.52	3.52	3.52
ZIMBABWE	ZWE	2.37	2.37	2.37	2.37	2.9	2.9	2.9	2.9

Appendix 3

Convergence Problem

In Model 2, the variable GDP85 has a positive coefficient, which is unexpected. Models 5-9 are presented here in order to answer any questions about the possible relationship between convergence and IPR. Models 5-7 are based on Models 2-4, but with the IPR variable removed. Models 8 and 9 introduce an interaction term between GDP85 and Growth90.

Model 5: Model 2 without the IPR variable
Growth95 = -4.531 + .038 School_1990 + .240 Invest95 – 3.999 GDP85 (-5.13) (1.45) (5.93) (-.46)
Observations Used: 90 R-Squared value: .358

Removing the IPR variable from Model 2 causes the GDP85 coefficient to become negative. It means that higher income countries tend to have slower growth rates. This effect is weak, and has a t-value less than one. When the IPR variable is included (such as in Model 2), higher income countries are not observed to always have slower growth rates.

Model 6: Model 3 without the IPR variable
Growth95 = -3.655 + .018 School_1990 + .202 Invest95 + .220 Growth90 (-3.80) (0.97) (4.62) (2.11)
Observations Used: 90 R-Squared value: .388

Removing the IPR variable from Model 3 has little effect on the coefficient or t-value of the lagged economic growth variable. The effect of schooling seems to be especially weak in this model.

Model 7: Model 4 without the IPR variable
Growth95 = -3.600 + .029 School_1990 + .197 Invest95 – 5.122 GDP85 (3.72) (1.11) (4.43) (-0.61) + .224 Growth90 (2.14)
Observations Used: 90 R-Squared value: .391

In Model 7, the static GDP variable again has a negative coefficient, and a t-value less than one. In Model 7, higher income countries seem to grow slower then slower income ones. The effect is slightly stronger in Model 7 than in Model 5, which does not include a lagged economic-growth variable.

Model 8: Model 5 without the IPR variable
Growth95 = -3.674 + .032 School_1990 + .189 Invest95 + 5.045 GDP85 + .492 Growth90 (-3.88) (1.26) (4.33) (.54) (3.13) – 7.012 GDP_Growth (-2.24)
Observations Used: 90 R-Squared value: .425

In Model 8, GDP_Growth has negative coefficient, significant at the 10 % level of significance, just like in Model 5. In Model 8, unlike in Models 5 and 7, GDP85 has a positive coefficient. This is more similar to that of Models 2 and 4, which have an IPR variable included. The coefficient of Growth90 is much stronger than in Model 6 and 7.

Model 8 demonstrates what I would like to call dynamic convergence. Certain countries grow faster than other countries, all other things being equal. Other countries fall behind, or even experience a period of negative economic growth. Countries in general are not observed to be converging, because the countries with advanced economies tend to be growing slightly faster, all other things being equal. Those